一般系統理論及其應用

楊連凱 王師復 楊維楨 葉學志 張果爲
柯輝芳 馬起華 楊孝濚 黃光國 蕭新煌

中美文化經濟協會科際整合促進委員會出版
漢苑文化事業有限公司印行

一般系統理論及其應用研討會紀錄

七十年十一月廿一——二日中美文化經濟協會，在會內會議廳召開一般系統理論及其應用研討會，其目的在於推廣這新的世界觀之研究，進一步以之作爲科際整合的手段。會議特邀請世界一般系統研究會兼國際系統研究聯合會會長，美國州立紐約大學賓漢頓分校系統學系教授，卡立爾博士，來台提出專題演講，並主持討論會。與會人士包括國內對此問題有興趣的知名立法委員、學者教授等八十餘人，會中提出八篇論文，以供討論。

該次研討會的歷程如下：

主席：本會理事長查良鑑博士

致辭：教育部李模次長

演講：卡立爾會長，演講題目爲「一般系統」簡介

報告：科際整合促進委員會主任委員王師復教授

論文：

一　王師復教授：白塔蘭斐一般系統理論及其應用的技術層次

二　楊維楨教授：系統分析的觀念

三　葉學志教授：系統理論在教育行政上的應用

四　張果爲教授：經濟循環的整合診斷—台灣實例

五　馬起華教授：一般系統理論對研析政治系統之可能性

六　楊孝濚教授：一般系統理論與我國社會福利體系之發展

七　黃光國教授：台灣家族企業系統之研究

八　葉新煌教授：民初國家發展策略—世界系統的分析

以上各篇論文之講論分爲四個階段，分別由考試委員楊必立、徐佳士、李亦園、文崇一諸教授主持，並由劉福增、張春興、黃榮村、楊日然、袁頌西、范珍輝、張曉春、謝繼昌、賴金男及其他教授參加討論，最後由楊國樞教授作綜合報導。立法委員王世憲致閉幕辭，結束第一天會議。

十一月廿二日，在原地點，由科際整合促進會王師復教授召開討論會，由卡立爾會長主講一般系統的方法論。隨後各與會人士提出問題，會後聚餐。

紀錄附件

查理事長良鑑開幕詞

各位貴賓，本會理事及會員

本會今天能夠舉行一般系統理論及應用研討會，該算是本會科際整合促進會各位教授三年來努力的表現。承蒙各位貴賓蒞臨參加，本會至感榮耀；特別對教育部李次長代表朱部長到會指導，及遠從美國蒞台參加本會主講一般系統理論的克立爾教授（George Klir）更感盛意。本人代表本會同人向各位蒞臨貴賓謹致敬意與謝忱。

一般系統理論及其與科際整合的關係，是最近廿六年中，西方，特別是美國，一種新的文化與科技運動。國內對此運動尚屬首創。這次研討會不過是首度的嘗試，希望能吸引朝野人士的注意，進而認識其重要性，擴大研究，以促進其發展。無論對國內教育文化以及各特種科技的增進，無論對國外新科學觀與文化主潮的貢獻，這項工作必然有其顯著的效果。但工作的艱巨也是顯而易見的。具有如此重大意義的工作，我們相信，只要用無比的毅力與興趣，即使臨艱巨的環境，也一定可以發揮其突破的能力。

在這裏，我們要特別介紹不遠千里而來的克立爾教授。他是美國「一般系統研究會」（Sociely for General Systems Research）會長。他現任美國紐約州立大學賓

漢頓（ Binghamton ）分校教授兼系主任。他原籍捷克，十數年前排脫共產政權的控制，走向民主自由的美國。他是電腦科學家，數學家，同時也是系統理論家，知識淵博。他曾寫過大量有價值的著作，並主辦國際一般系統專刊，現已達廿餘年。同時他也是系統研究國際聯合會，（ International Confederation for Systems Research ）會長。這是一個具有國際權威的系統研究機構。這次他能夠蒞臨本研討會，爲我們介紹「一般系統理論」，實爲本會的重大收穫。

最後，這次研討會的籌劃，係科際整合促進會各位教授通力合作的結果，除對他們的努力感謝外，本人特別爲他們的創舉而表示敬意，並希望其能一秉初衷與勇往直前的精神繼續努力。本人相信，今後定有更大的成就，轉移社會風氣與文化導向，增進中美文化的關係。這次研討會，承教育部及本會常務理事劉濶才副院長的特別支持，本人代表本會同仁謹致謝意。

教育部次長李模先生致詞

主席，克立爾博士，各位來賓：

今天中美文化經濟協會舉辦一般系統理論與應用研討會，本人非常高興能夠代表教育部來參加。這幾天，朱部長因忙於立法院會議，未克分身，他特別囑本人爲他代致賀忱。。

一般系統理論是一種新的世界觀，供爲科際整合的共通基礎，這個新的文化運動能夠被帶進我國，實爲國內一件重大的事件。同時，在教育方針上，我們也早已深深感到科際整合的需要。現在大學法規定成績優良的學系得設立研究所。這種各科獨立，培養專才的教育，雖有成效，但事實已證明其缺點，許多問題的研究，却非某一系所能獨立承擔的、我們很需要，各科系有個共同的研究所，在共同的基本觀念下，以不同的知識，互相溝通，互相研究。這種整合教育，在國外已獲若干人士的重視，整合教育與科際整合是不可分開的。不過，一種新的教育制度是需要相當時期的醞釀檢討與研究，才能完成的。本人希望這次研討會能夠帶頭推動并擴大科際整合運動，進而對我國教育文化提供具體構想，逐漸建立新的教育系統。

本人對一般系統理論沒有研究，但在經驗上却深深感到研究必須建立在廣博知識基礎上面的。同時科際關係在科技迅速發展的今日，是愈來愈密切了，沒有任何知識成果能由

某一種科技獨自完成的。而欲求各種不同科技能互相整合，必須有共同的看法。以異求同，才能找到眞正根源，進而以同求異，觸類旁通，使各種科技能作平行的發展，創造一個知識的整體。這點可說是與這次研討會的宗旨不謀而合。因此本人對這次研討會深感興趣，並寄望於有關這方面的學人們能更上層樓，相信不久將來，我國教育文化能因之而獲到長遠的成就。

最後，敬祝本會有圓滿的結果。

王主任委員師復報告

各位貴賓：

中美文化經濟協會，在民六十八年十月，創立科際整合促進會（F簡稱本會），其目的不僅在於順應國際現代新思潮，加強中美文化的溝通，主要還在於促進國內科學的發展，提高文化教育，改變社會風氣，並提供各界研究計劃的諮詢。

參加本會的人士，以台北地區各大學各院系教授中對科際整合有認識，有興趣者為主。草創之初，同時受到中美文化經濟協會所屬各委員會組織人數規定的限制，本會未能廣邀更多學人。我們相信，還有許多人士對此工作至有認識，更感興趣者，未能一一羅致，至感虧欠。不過，本會不重形式，而以工作目標為主，故有志一同之者，我們都歡迎其能加入共同研究與溝通意見。

這次研討會不顏以「科際整合」，而為「一般系統理論及其應用」，原因是為了不同科學之能整合，其先決條件即為整合所需的共通基礎。本世紀卅年整合思潮蔚然一時。而在缺乏共通基礎下，只好用物理學來填充。從而產生科學的物理學化的運動，偏重形式的整合。而「一般系統理論」則為本世紀五十年代以來，被視為更能滿足這種整合共同基礎的需要。在過去三年中，本會同人曾對此理論加以研究與商討，雖然看法有所差異，但站在科學立場，求同而不排除其

異。同時一般系統理論，對科際整合，並不提供任何形式的條件，只貢獻啓發的功效，或只提供整合的共同觀點。這與本世紀卅年代所討論的科際整合，大異其趣。它是重視觀點的整合。事實證明，骨架，語言以及其他形式的整合，曾嚴重影響到各種科學本身的正常發展，形成畸形的文化。這次研討會並不表示對於一般系統理論有何深入的認識，只是在觀念上，無論同意與否，大家都多少對之獲到某種程度的感受。同時，當做整合手段的一般系統理論，也無須視之爲專門知識而加研究。至其運用全憑各種科學研究者，按其個別特性，作最適的選擇。一般系統理論者都沒有自認爲學術的權威；反之，他們都是反對學術權威的。同時，他們也都是實踐家、着重應用的實效。卅年代的科際整合思潮，雖也曾衝擊到國內學壇，但仍停留在醞釀階段。觀念整合雖與形式整合不同，但其目標則一。這次研討會的動機無非將整合工作從私人商討進而公之於衆，逐步爭取實效。故與其說它是本會工作的結果，不爲說它是我們研究的開端。

這次研討會原擬於本年三月舉行，但因種種問題，一直延到今天。原因之一，是因美國一般系統學會會長，克立爾教授，到現在才能分身前來參加。再因本人返國後受私事影響及健康情況欠佳，一直到了本月才着手籌備。一切簡陋，考慮不周，不勝惶恐。尚希預會諸公原諒，謝謝！

王常務理事世憲閉幕詞

主席，各位來賓，各位會員

有關一般系統理論方面的研討會，在國內這次尚屬首創。有美國一般系統研究會會長，克立爾博士，主講，有各位教授提出論文並分別討論，這些都是各種研討會所追求的目標，而我們現在都能一一做到，因此本人認定這次研討會慶典是成功而完滿舉行了。這不能不歸功於本協會科際整合促進會各先生的努力。本人十分欣佩。

科際整合係爲人所共知，而以一般系統理論作爲整合基礎却是新的動向。這次研討會也許會使國內各界有所認識，進而共同促進這個新的運動。本人希望今後大家能更進一步研究，更進一步研討其功用。則以這次好的開頭，我們將會不斷產生更好的成就，讓今後研討會一次一次的爆出燦爛的火花。

在這次研討會閉幕階段，本人謹以萬分的熱忱預祝科際整合運動的成功。謝謝。

A LIST OF PAPERS PRESENTED TO THE CONFERENCE FOR GENERAL SYSTEMS THEORY AND ITS APPLICATION HELD ON 21-22, NOVEMBER, 1981 IN TAIPEI, TAIWAN, THE REPUBLIC OF CHINA

Systems Science-A New Dimension in Science (Keynote Speech)
By George Klir, President, Society for General Systems Research, Professor and Chairman, Department of Systems Science, State Universitv of New York at Binghamton. (with Chinese vevsion)

Bertalanffy's General Systems Theory and Its Application On the Strategic Level
By Shi-Fu Wang, Convener, Committee for The Advancement of Interdisciplinary Integration, Professor of Economics, National Taiwan University

On The Concept of A System Analysis
By V. C. Yang, Professor of Electrical Engineering, National Taiwan University

The Application of System Theory to Educational Administration
By H. J. Yeh, Professor and Dean, National Chengchi University

An Integrative Diagnosis of the Business Cycles-The Case of Taiwan

By K, W. Chang, Professor and Director, Graduate School of Economics, Chinese Cultural University

General Systems Theory and Political System Model
By Chi-Hua Ma, Professor of Political Science, National Chengchi University

General Systems Theory And Community Development in Taiwan-An Evaluation on the Basis of A-Case Study
By Shou-Jung Yang, Professor and Chairman, Department of Sociology, Soochow University

An Inquiry Into the Family Enterprised Systems in Taiwan
By K. K. Huang, Professor, Department of Psychologym National Taiwan University

The National Development Strategy in the Early Republic of China.An Analysis of the then-Globle Systems
By H. W. Yeh

1. Introduction

One of the major characteristics of science in the second half of this century is the emergence of a number of related intellectual areas such as cybernetics, general systems research, information theory, control theory, mathematical systems theory, decision analysis and artificial intelligence. All these areas, whose appearance and development are strongly correlated with the origins and advances of computer technology, have one thing in common: they deal with such systems problems in which informational, relational or structural aspects are highly predominant while, on the other hand, the kind of entities which form the system is considerably less significant. It has increasingly been recognized that it is useful to view these interrelated intellectual developments as parts of a larger field of inquiry, usually referred to as systems science.

If systems science is a science in the usual sense, then three basic components should be distinguished in it:

(i) a domain of inquiry;

(ii) a body of knowledge regarding the domain;

(iii) a methodology (a coherent collection of methods) for the acquisition of new knowledge within the domain as well as utilization of the knowledge for dealing with problems relevant to the domain.

It is the purpose of this article to characterize these three components--the domain, knowledge and methodology--of systems science. Moreover, it is argued that systems science is not comparable with the other sciences and, consequently, it is appropriate to view it as a new dimension in science.

2. Classification of Systems

It is fair to say that the domain of each scientific discipline is a particular class of systems. The term "system" is used here in the general sense of a typical definition given by a common dictionary, i.e., it refers to a set of some things (attributes, variables, objects, components, phenomena, etc.) which are related in some fashion and through this relationship form a coherent whole. These two aspects--a set of things of some sort and a relation with some characteristic features--[1], which are recognizable in every system, are two obvious bases for classifying systems. Hence, a class of systems can be introduced by one of two fundamentally different criteria:

(a) by a restriction to systems which are based on certain kinds of things;

(b) by a restriction to systems which are based on certain kinds of relations.

Classification criteria (a) and (b) are orthogonal in the sense that they do not restrict each other and can be combined if desirable. Criterion (a) is exemplified by the traditional classification of science and technology into disciplines and specializations, each focusing on the study of certain kinds of things (physical, chemical, biological, political, economic, etc.) with no commitment to any particular kind of relations. Since different kinds of things require different experimental (instrumentation) procedures for data acquisition, this classification is essentially experimentally-based.

[1]The term "relation" is used in this paper in broad sense to encompass the whole set of kindred terms such as "structure," "constraint," "information," "organization," "interconnection," and the like.

Criterion (b) leads to fundamentally different classes of systems, each characterized by a specific kind of relations with no commitment to any particular kind of things on which the relations are defined. This classification is related to data processing rather than data acquisition and, as such, it is theoretically-based.

As discussed later in the paper in more detail, the largest classes of systems based on criterion (b) are those which characterize various epistemological levels. They are further refined by various methodological distinctions. The smallest classes of systems are those which are equivalent in terms of their relations, i.e., classes of isomorphic systems. Since systems in each particular isomorphic class may be based on quite different kinds of things, it is useful to pick up one of the isomorphic systems as a representative of the class. Such systems are called general systems and are defined as standard and interpretation-free systems, each of which is chosen to represent a class of systems equivalent with respect to their relational aspects under some desirable pragmatic criteria. The term "standard" is used here to refer to a description which satisfies certain conventions, influenced primarily by the use of the system; some convenient form by which the system is represented on a computer, for example, may be accepted as a standard description.

While systems classification based on criterion (b) is foreign to traditional science, its significance has increasingly been recognized. All activities involved in the study of those properties of systems and relevant problems which emanate from this classification are now becoming identified with the general name "systems science." In this sense, "systems science" is a name for scientific activities which are theoretically-based and complementary to the experimentally-based activities of the traditional science.

3. Systems Science

The domain of systems science consists of all kinds of relational properties which are valid for particular classes of systems or, in some rare instances, are valid for all systems. The chosen relational classification of systems determines the way in which the domain of systems is divided, into subdomains in a similar fashion as the domain of the traditional science has been divided into subdomains of the various disciplines and specializations.

Knowledge of systems science, i.e., knowledge regarding the various classes of relational properties of systems, can be obtained either mathematically or through experiments with systems simulated on a computer.

Examples of mathematically derived knowledge in systems science are the Ashby law of requisite variety [1,2], the principles of maximum entropy and minimum cross-information [36], or the various laws of information which govern systems [10,43].

Examples of experimentally derived knowledge are the various results regarding the effect of the size of a system (the number of variables involved) and its connectance (the percentage of dependencies among the variables) on the probability of stability associated with various classes of systems [13,14,17,29,30], knowledge regarding the relationship between structures and behaviors of systems [32], dependence of average cycle length and other behavioral characteristics on the size of the system [16,41,42], or various characteristics for the reconstructability analysis [22,25,26].

Mathematically derived systems knowledge can sometime be usefully complemented by comparable knowledge derived by computer simulation. For example, experimental investigations regarding the probability of stability of linear systems were performed by Gardner and Ashby for systems with no more than 10 variables [14]. A later study by May [31] complemented their investigations with analytical analysis of the same class of systems in "the limit when the number of variables is large." His mathematical results basically agree with the experimental results, although for small number of variables there is some discrepancy, which is obviously due to the assumption of large number of variables in the analytical approach.

As far as the experimentally derived knowledge, it is the computer which represents the laboratory for systems science. It allows the systems scientist to perform experiments in exactly the same way other scientists do in their laboratories, although the experimental entities he deals with are abstract structural properties (simulated on the computer) rather than specific properties of the real world [26].

Systems methodology is a coherent collection of methods for studying relational properties of various classes of systems and for solving systems problems, i.e., problems which deal with the relational aspects of systems. A useful classification of systems from the relational point of view is the kernel of systems methodology. When properly developed, the classification is a basis for a comprehensive description and taxonomy of systems problems. The ultimate goal of systems methodology is to provide potential users in various disciplines and problem areas with methodological tools for all the recognized types of systems problems.

From the standpoint of the disciplinary classification of traditional science, systems science is clearly cross-disciplinary. There are at least two important implications of this fact. Firstly, systems science knowledge and methodology are directly applicable, at least in principle, in virtually all disciplines of traditional science. Secondly, systems science has the flexibility to study relational properties of such systems and the associated